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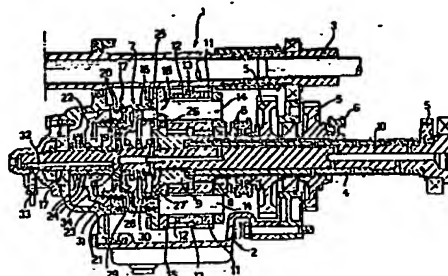
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(54) A tractor gearbox with a hydraulically-controlled, two-speed transmission-ratio variator.

(57) A tractor gearbox with a transmission-ratio variator (7) with two speeds, fast and slow respectively, including an epicyclic unit having an input member (8) rotated by the countershaft (4) of the gearbox (1) and an output member (9) rotated by means of two hydraulically-operated friction clutches (17, 18) which can be engaged and disengaged alternatively without interrupting the torque transmission.



## Description

**A tractor gearbox with a hydraulically-operated, two-speed, transmission-ratio variator**

The present invention relates in general to tractor gearboxes.

More particularly the invention relates to a gearbox of the type including a main shaft which is rotated by the tractor engine through a friction clutch and to which a plurality of driving gears are coupled for rotation, a counter shaft on which a plurality of driven gears meshed with the driving gears are rotatably mounted, mechanically-operated engagement-synchronising means for selectively connecting the driven gears for rotation with the counter shaft and a transmission-ratio variator with two speeds, fast and slow respectively.

In known gearboxes of the type defined above, the transmission-ratio variator is normally arranged upstream of the gearbox, between the friction clutch of the tractor and the main shaft of the gearbox.

Such arrangements can have the disadvantage that the correct operation of the means for synchronising the engagement of the speed ratios of the gearbox is altered by the variator. Moreover, the variator is usually unable to ensure mechanical continuity of the drive when the tractor engine is switched off, and is generally rather bulky.

The object of the present invention is to avoid the above problems and to produce a tractor gearbox of the type defined above in which the operation of the means for synchronising the engagement of the gear ratios is not altered by the variator, and in which the latter is simple to produce, less bulky and very effective in operation.

According to the invention, this object is achieved by virtue of the fact that the transmission-ratio variator is situated downstream of the gearbox and comprises an epicyclic unit having an input member rotated by the counter shaft of the gearbox and an output member rotated through two hydraulically-operated friction clutches which can be engaged and disengaged alternatively without interrupting the torque transmission from the counter shaft of the gearbox to the output member of the epicyclic unit.

According to a preferred embodiment of the invention, the counter shaft of the gearbox is hollow and the epicyclic unit comprises:

a first sun gear coupled for rotation with the counter shaft,

a second sun gear coupled for rotation with an output shaft which passes through and is rotatable coaxially in the counter shaft,

a planet-carrier coaxial with the output shaft and carrying a series of planets with two sets of teeth of which the first set meshes with the first sun gear and the second set meshes with the second sun gear, the planet-carrier being selectively lockable against rotation by means of the engagement of the first of the two friction clutches or connectible for rotation with the second sun gear by means of the engagement of the second of the two friction clutches; resilient means being provided for keeping the first friction clutch normally engaged.

By virtue of this conformation, the continuity of the

drive through the epicyclic unit is ensured even when the tractor engine is switched off, as well as in the event of damage to the hydraulic operating system.

The invention will now be described in detail with reference to the appended drawing, provided purely by way of non-limiting example, which shows a tractor gearbox according to the invention schematically and in axial section.

With reference to the drawing, a tractor gearbox is generally indicated 1 and includes a casing 2 which rotatably supports a main shaft 3 which is rotated by the tractor engine through a friction clutch, not illustrated, and a counter shaft 4.

A series of driving gears are fixed to the main shaft 3 for rotation therewith, there being the same number of driving gears as gear ratios of the gearbox 1. The driving gears, which are not shown in the drawing for simplicity of illustration, are meshed with the same number of driven gears, three of which are indicated 5 in the drawing, which are freely rotatable on the counter shaft 4. The driven gears 5 are selectively engageable for rotation with the shaft 4 by means of respective mechanically-operated sleeve couplings, two of which are indicated 6, with operatively-associated synchronising devices, not illustrated, which are conventional to an expert in the art.

The gearbox 1 also includes a two-speed transmission-ratio variator, generally indicated 7, situated within the casing 2, downstream of the driven gears 5, that is, at the output of the counter shaft 4. This variator 7 enables the output ratio of the gearbox 1 to be varied with two speeds, fast and slow respectively, without the operation of the friction clutch situated upstream of the gearbox 1, and without interruption of the driving torque transmission.

The variator 7 is constituted by a compact epicyclic unit including an input sun gear 8 coupled for rotation with the inner end of the counter shaft 4, and an output sun gear 9. The counter shaft 4 is hollow and the output sun gear 9 is coupled for rotation with an output shaft 10 which passes through and is rotatable coaxially in the counter shaft 4.

The input sun gear 8 and the output sun gear 9 mesh with teeth 11 and 12 respectively of a series of planets 13 which are rotatable on axial pins 14 carried by a planet-carrier 15 coaxial with the output shaft 10.

The planet carrier 15 is firmly fixed to a bell member 16 carried by an auxiliary shaft 17 rotatably mounted in the casing 2 and aligned with the output shaft 10.

The bell member 16 constitutes the driving member of first and second hydraulically-operated friction clutches indicated 17 and 18 respectively.

The first friction clutch 17 includes a series of driving friction discs 19 which rotate on the outside of the bell member 16 and between which are

interposed driven friction discs 20 carried by a fixed annular member of stator 21 firmly fixed to the casing 2. A first pressure plate 22 is operatively associated with the friction discs 19 and 20, and is sealingly slidable on the outside of the bell member 16, defining therewith a first thrust chamber 23. The pressure plate 22 is normally urged by a pack of Belleville washers 24, coaxial with the auxiliary shaft 17, into the position in which the friction discs 19 and 20 are clamped together. In the absence of pressure in the thrust chamber 23, the washers 24 thus tend to keep the first friction clutch 17 in the engaged condition. In this condition, the bell member 16, and hence the planet carrier 15, are locked to the annular member 21 against rotation and are therefore kept stationary relative to the casing 2.

The second friction clutch 18 includes a series of driving friction discs 25 coupled to the inside of the bell member 16, and between which are interposed driven friction discs 26 carried by a ring-shaped appendage 27 of the output sun gear 9.

A second pressure plate 28 is operatively associated with these friction discs 25 and 26 and is sealingly slidable like a piston within the bell member 16 on the opposite side from the first pressure plate 22, defining with the bell member 16 a second thrust chamber 29.

A helical compression spring 30, coaxial with the auxiliary shaft 17, urges the second pressure plate 28 away from the friction discs 25 and 26 so that, in the absence of pressure in the thrust chamber 29, the second friction clutch 18 is kept in the disengaged condition. In this condition, the planet-carrier 15 is freely rotatable relative to the output sun gear 9.

In the embodiment illustrated, the two thrust chambers 23 and 29 of the two friction clutches 17 and 18 are interconnected by means of axial passages 31, and the connection with the hydraulic circuit for operating these clutches is achieved by means of a single passage 32 formed in the auxiliary shaft 17 and connected at one end to a fixed supply connector 33 and at its opposite end to the thrust chamber 29 through one or more passages 34 formed in the bell member 16.

In operation, the drive imparted to the counter shaft 4 by the driven gear 5 which is selected and engaged in accordance with the chosen gear ratio, is transmitted by the sun gear 8 to the epicyclic unit 7 and from this through the output gear 9 to the output shaft 10. If pressurised hydraulic fluid is not supplied to the duct 32, and hence to the chambers 29, 23, the second friction clutch 18 is kept disengaged by the spring 30, whilst the friction clutch 17 is kept engaged by the Belleville washers 24. In this situation, the planet-carrier 15 is locked against rotation, corresponding to the rotation of the output shaft 10 at a slow speed, with a transmission ratio of the order of 1:1.1666. This same condition also occurs if there is any damage to the hydraulic supply system of the clutches 17 and 18 so that the mechanical continuity of the drive is ensured in any case.

If pressurised hydraulic fluid is delivered to the chambers 29 and 23 through the passage 32, the

second friction clutch 18 is engaged and the friction clutch 17 is disengaged simultaneously as a result of the axial displacement of the two pressure plates 28 and 22 in opposite directions against the actions of the spring 30 and of the washers 24. In this situation, the planet-carrier 15 is made fast for rotation with the output sun gear 9 so that the output shaft 10 is put into direct engagement with the counter shaft 4, producing a transmission ratio of 1:1.

The changeover between the engagement of the clutch 18 and the disengagement of the clutch 17 and vice versa, which is necessary to ensure continuous transmission of the torque, is achieved by suitable calibration of the helical spring 30.

In order to optimise the changeover graph for the engagement/disengagement of the clutches 17 and 18, a variant (not illustrated) is envisaged with duplicated supply to the thrust chambers 23, 29 through respective passages formed in the auxiliary shaft 17 and in the bell member 16. In this case the intercommunication passages 31 between the chambers 23 and 29 are closed.

The duplicated supply may be controlled electronically by means of a control unit which operates in dependence on external operating parameters (drive engaged, oil temperature, rate of rotation of the tractor engine) so as to vary the changeover graph of the two clutches 17 and 18 and thus render the operation of the epicyclic unit 7 dependent on the prevailing operating conditions of the tractor.

## Claims

1. A tractor gearbox including a main shaft which is rotated by the tractor engine through a friction clutch and to which a plurality of driving gears are coupled for rotation, a counter shaft on which a plurality of driven gears meshed with the driving gears are rotatably mounted, mechanically-operated engagement-synchronising means for selectively connecting the driven gears for rotation with the counter shaft and a transmission-ratio variator with two speeds, fast and slow respectively, characterised in that the variator (7) is situated downstream of the gearbox and comprises an epicyclic unit having an input member (8) rotated by the counter shaft (4) of the gearbox (1) and an output member (9) rotated through two hydraulically-operated friction clutches (17, 18) which can be engaged and disengaged alternatively without interrupting the torque transmission from the counter shaft (4) of the gearbox (1) to the output member (9) of the epicyclic unit.

2. A gearbox according to Claim 1, characterised in that the counter shaft (4) of the gearbox (1) is hollow and the epicyclic unit (7) comprises:

- a first sun gear (8) coupled for rotation with the counter shaft (4),
- a second sun gear (9) coupled for rotation with an output shaft (10) which passes through and

is rotatable coaxially in the counter shaft (4),  
 - a planet-carrier (15) coaxial with the output  
 shaft (10) and carrying a series of planets (13)  
 with two sets of teeth (11, 12) of which the first  
 set (11) meshes with the first sun gear (8) and  
 the second set (12) meshes with the second  
 sun gear (9); the planet-carrier (15) being  
 selectively lockable against rotation by means  
 of the engagement of the first (17) of the two  
 friction clutches or connectible for rotation with  
 the second sun gear (9) by means of the  
 engagement of the second (18) of the two  
 friction clutches; resilient means (24) being  
 provided for keeping the first friction clutch (17)  
 normally engaged.

3. A gearbox according to Claim 2, charac-  
 terised in that the epicyclic unit (7) includes an  
 idle auxiliary shaft (17) which is aligned with the  
 output shaft (10) and to which a bell member  
 (16) firmly fixed to the planet-carrier (15) is  
 coupled for rotation, the bell member having  
 associated therewith, on opposite sides, first  
 and second series of driving friction discs (19,  
 25) cooperating with first and second series of  
 driven friction discs (20, 26) carried by a fixed  
 structure (21) and by the second sun gear (9)  
 respectively; first and second pressure plates  
 (22, 28) respectively being operatively associ-

ated with the friction discs (19, 20; 25, 26) and  
 defining with the bell member (16) first and  
 second thrust chambers (23, 29) respectively  
 connected to hydraulic operating means for  
 supplying pressurised hydraulic fluid; the sup-  
 ply to the first chamber (23) causing the  
 movement of the first pressure plate (22) away  
 from the corresponding friction discs (19, 20)  
 against the action of first resilient biasing  
 means (24) and the supply to the second  
 chamber (29) causing the movement of the  
 second pressure plate (28) towards the corre-  
 sponding friction discs (25, 26) against the  
 action of second resilient biasing means (30).

4. A gearbox according to Claim 3, charac-  
 terised in that the hydraulic operating means  
 include common passages (32, 34) for the  
 supply of the two thrust chambers (23, 29) and  
 in that the two thrust chambers (23, 29) are in  
 communication with each other.

5. A gearbox according to Claim 3, charac-  
 terised in that the hydraulic operating means  
 include separate passages for the supply of the  
 two thrust chambers and electronic control  
 means operating in dependence on the opera-  
 tive conditions of the tractor.

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